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BODY COMPOSITION OF *OREOCHROMIS MOSSAMBICUS* IN RELATION TO BODY SIZE AND CONDITION FACTOR

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Abstract: Sixty three wild *Oreochromis mossambicus* with body sizes ranging from 2.5 – 18.6 cm in total length (TL) and 0.22 – 128.65 gm in wet body weight (W) were sampled for analysis of body composition parameters in relation to body size and condition factor. It was observed that highly significant inverse correlation exist between water content (%) and organic, fat, protein and ash contents (%, wet body weight) respectively. The condition factor has a highly significant inverse correlation with water content while it has highly significant positive correlation with organic, fat, protein and ash contents (%wet body weights). If it is impossible to determine the water content then the body constituents can be estimated from total length, wet body weight and condition factor of this species within the size range studied. As the variations in body composition are related to these variables, so the equations of each constituent were estimated. The predictive equations can be used to estimate values of body composition with a fair amount of accuracy.

Keywords: Body composition, O*reochromis mossambicus*, body size, condition factor

INTRODUCTION

Tilapia culture appears to be the oldest form of aquaculture. Since it is known to have been practiced in Egypt as far back as 2500 B.C., and has continued in that country and others until the present day [Caceci *et al*. 1997]. During the last 40-50 years, Tilapias have been distributed throughout the world [Mirza 1975]. The first probably accidental introduction of Tilapia outside Africa was that of *O.mossambicus* prior to 1939 in Java [Pullin 1982]. In Pakistan, it was first introduced in 1951. Many countries have imported these species because they can live successfully in brackish water [Mirza 1990].

The percentage water in the fish is a good indicator of its relative content of energy, proteins and lipids; the lower the percentage of water, the greater the lipid and protein contents and higher the energy density of the fish. This means that from measuring the relative amount of water in the fish, one can obtain relatively good estimates of the energy, fat and lipid contents [Salam and Davies 1994, Jonsson and Jonsson 1998].

In ecological studies where fluctuations in body size and condition are monitored, the lipid content of an animal is often estimated from the relationship between percentages of water and fat [Salam and Davies 1994]. Such estimates are used simply because the measurement of water is easy and rapid. These relationships have been shown to exist in various fish species, and have been extensively used for predictive estimates [Elliott 1976, Caulton and Bursell 1977, Brett 1979, Jobling 1980, Weatherley and Gill 1987, Salam and Janjua 1991, Salam *et al*. 1991, Salam and Davies 1994, Jonsson and Jonsson 1998]. Body composition parameters are good indicators of the physiological condition of a fish but it is time consuming to measure them. Indices of condition that can easily and conveniently be measured proved to be good indicators of body composition and growth of fish, are essentially needed for routine analysis of fisheries [Cui and Wootton 1988, Salam and Davies 1994]. The main objective of the present study was to obtain data on the quantity of water, fat, protein, and ash contents, and how they fluctuate in relation to body size and the condition factor (K) in riverine *Oreochromis mossambicus* (Peters).

MATERIALS AND METHODS

Sixty-three specimens of Mozambique Tilapia, *Oreochromis mossambicus* of variable body sizes were collected for laboratory studies from a water body of Ghazi Ghat (Indus River) with the help of a cast net. These were transported in plastic containers to the Fish Research Laboratory, Institute of Pure and Applied Biology, Bahauddin Zakariya University, Multan. All specimens of *O. mossambicus* were weighed singly on an electronic digital balance (MP-3000 *Chyo*, Japan) to the nearest 0.01gram. Total body length was measured to the nearest to 0.01cm.

Body composition of each fish was determined following the methods of Elliott [1976], Caulton and Bursell [1977], Cui and Wootton [1988], Salam and Davies [1994]. In the present study, no attempt has been made to calculate the carbohydrate contents.

A very widely used index in fish ecology studies is the Fulton's Condition Factor (K) and is calculated by the formula [Weatherley 1972, Ricker 1975, Wootton 1990, Salam and Khaliq 1992, Salam and Mahmood 1993]:

$$\text{Condition factor} = \text{Weight} / \text{Length}^3 \times 100$$

Or $$K = W/L^3 \times 100$$

Regression analysis and calculation of correlation coefficients were carried out with the help of computer packages, Excel and Minitab.

RESULTS

The variations observed in the data and their inter-relationships were analyzed and described in sections below:

1. **Relationship between water content and other body constituents**
   It was found that organic, fat, protein and ash contents (%, wet weight) show inverse relationships with water contents (Fig. 1, a-d). All these relationships were highly significant (P < 0.001).
2. **Relationship between condition factor (K) and body constituents**
   Condition factor has a highly significant (P< 0.001) inverse correlation with water content, highly significant (P < 0.001) positive correlation with organic, fat, protein and ash contents (%, wet weight), while non-

significant (P > 0.05) correlation with organic, fat, protein and ash contents (%, dry weight) (Table 1).

3. Relationship between body constituents and body size

All the equations developed for wet weight against total values of body constituents were found to be highly correlated (P < 0.001). Wet weight has positive influence on all contents (Table 2).

The equations developed to show relationships between total length and total values of body constituents were found to be highly significant (P < 0.001) and total length has positive influence on all types of contents (Table 3).

When total values of all body constituents i.e. water, organic, fat, protein and ash contents, were log transformed and plotted against log total length and log wet weight, a linear relationship is obtained having the form: log Y = log a + b log X. This relationship shows a high degree of correlation (P < 0.001) as in Tables 2 and 3. The value of exponent "b" on log-log scale for weight/weight is indicating isometric condition when b=1. The log-log relationship of total ash, organic, fat and protein contents with wet body weight showed highly significant correlations (P < 0.001) as in Table 2. As all these correlations have "b" value greater than 1 indicating positive allometry i.e. increasing with increasing wet weight, except total water content, which has b value 0.9817 which is less than 1; thus it decreases with wet weight showing negative allometry. The value of exponent "b" on log-log scale for weight/length, when increase in weight of constituents is Isometric, should be b = 3. The log-log relationships of total values of body constituents with total length showed highly significant correlations (P < 0.001) as in Table 3. Comparison of slope with b= 3 indicates that all these constituents are showing positive allometry with increasing total length as "b" value of all these constituents is greater than 3.

Table 1: Condition factor (K) versus % body constituents of *Oreochromis mossambicus*

RELATIONS	n	R	a	b	S.E (b)	t-value (when b = 0)
Condition factor (x) %Water contents (y)	63	-0.7605***	88.28	-6.0096	0.6571	9.15***
Condition factor (x) % Organic contents (dry weight) (y)	63	0.0245[ns]	79.15	0.162	0.8755	0.18[ns]
Condition factor (x) % Organic contents (wet weight) (y)	63	0.7241***	9.476	4.6478	0.5668	8.2***
Condition factor (x) % Fat (Dry weight) (y)	63	0.06[ns]	24.153	0.731	1.556	0.47[ns]
Condition factor (x) % Fat (Wet weight) (y)	63	0.4953***	2.4854	1.8133	0.4072	4.45***
Condition factor (x) % Protein (Dry weight) (y)	63	-0.0316[ns]	54.563	-0.361	1.484	-0.24[ns]
Condition factor (x) % Protein (Wet weight) (y)	63	0.6419***	6.7231	3.0255	0.4628	6.54***
Condition factor (x) % Ash (Dry weight) (y)	63	0.055[ns]	19.706	0.4531	1.059	0.43[ns]
Condition factor (x) % Ash (Wet weight) (y)	63	0.5248***	2.4952	1.1897	0.2471	4.81***

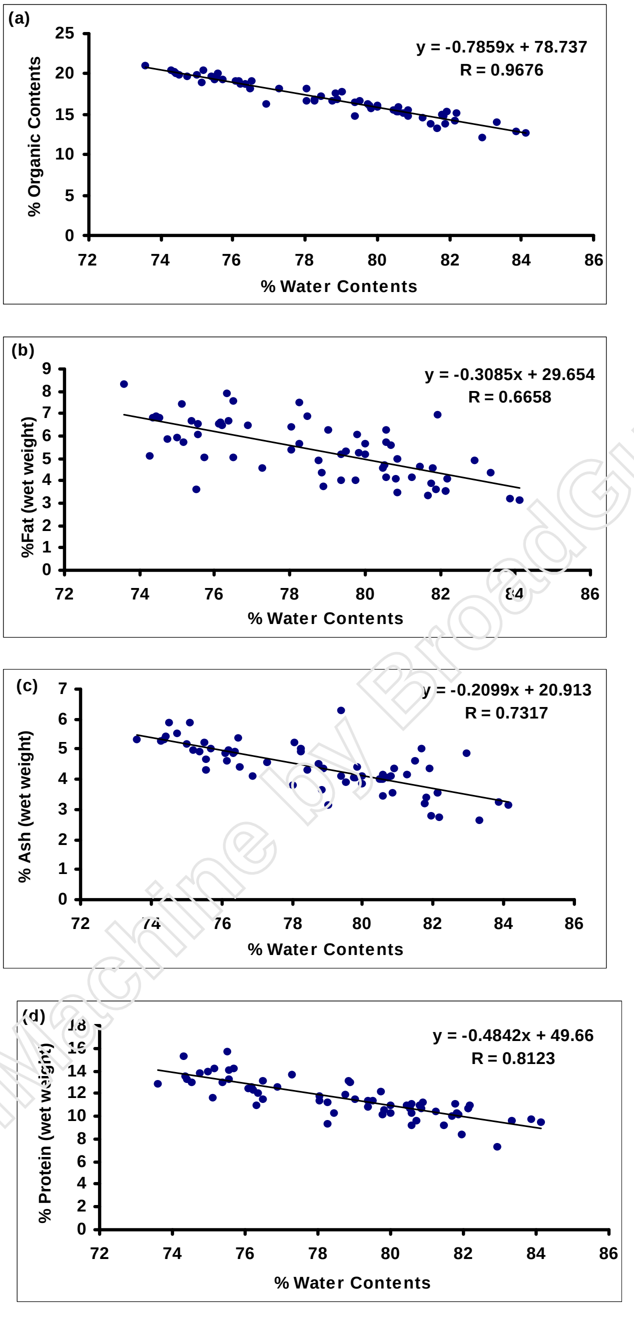

Fig. 1: Relationship between % water content and (a) % organic contents (wet weight), (b) % fat, (c) % ash content, and (d) % protein content of *Oreochromis mossambicus.*

Table 2: Wet body weight (w, g) versus total body constituents (g) of *Oreochromis mossambicus*: correlation coefficient (r), intercept (a), regression coefficient (b), standard error of b (SE) and probability (P)

RELATIONS	n	R	a	B	S.E (b)	t-value (when b = 1)
Wet body weight (x) Water contents (y)	63	0.999***	-0.0024	0.7632	0.00164	
Log wet body weight (x) Log water contents (y)	63	0.999***	-0.095	0.982	0.0018	10***
Wet body weight (x) Organic contents (y)	63	0.981***	-0.0264	0.1813	0.0046	
Log wet body weight (x) Log organic contents (y)	63	0.987***	-0.8071	1.0354	0.0218	-1.624 ns
Wet body weight (x) Fat (y)	63	0.996***	-0.0377	0.0691	0.0008	
Log wet body weight (x) Log fat (y)	63	0.994***	-1.3364	1.1068	0.0156	6.85***
Wet body weight (x) Protein (y)	63	0.992***	0.0506	0.1172	0.0019	
Log wet body weight (x) Log protein (y)	63	0.997***	-0.9678	1.0505	0.0104	4.856***
Wet body weight (x) Ash (y)	63	0.997***	-0.0088	0.0502	0.0005	
Log wet body weight (x) Log ash (y)	63	0.995***	-1.3999	1.069	0.0133	5.188***

Table 3: Total body length (TL, cm) versus total body constituents (g) of *Oreochromis mossambicus*: correlation coefficient (r), intercept (a), regression coefficient (b), standard error of b (SE) and probability (P)

RELATIONS	n	r	a	b	S.E (b)	t-value (when b = 3)
Total length (x) Water contents (y)	63	0.9065***	-20.5	4.393	0.262	
Log total length (x) Log water contents (y)	63	0.9954***	-2.1691	3.3316	0.0408	8.127**
Total length (x) Organic contents (y)	63	0.8845***	-4.8545	1.0373	0.0701	
Log total length (x) Log organic contents (y)	63	0.9787***	-2.9844	3.501	0.094	5.33***
Total length (x) Fat (y)	63	0.9054***	-1.9	0.399	0.0239	
Log total length (x) Log fat (y)	63	0.9899***	-3.6755	3.7572	0.069	10.974**
Total length (x) Protein (y)	63	0.9151***	-3.1722	0.6861	0.0387	
Log total length (x) Log protein (y)	63	0.9892***	-3.1776	3.5529	0.0674	8.203**
Total length (x) Ash (y)	63	0.9108***	-1.3695	0.2908	0.0169	
Log total length (x) Log ash (y)	63	0.9892***	-3.6529	3.6205	0.0685	9.058**

DISCUSSION

The highly significant ($P < 0.001$) inverse correlation observed in this study between water contents and other body constituents (organic, fat, protein and ash) when all are taken on % wet weight basis as shown in Fig. 1, is in general agreement with that reported by other investigators [Niimi 1972, Elliott 1976, Jobling 1980, Love 1980, Craig *et al*. 1989, Salam and Khaliq 1991, Salam and Janjua 1991, Salam and Davies 1994].

Actually changes in the feeding habits and condition of the fish during its growth process result in the changes of muscle fat: water ratio of a fatty or non-fatty fish. In fish with a good condition, water content decreases and the fat content increases while the water content of a non-fatty muscle rises during fasting or non-feeding phase due to utilization of protein for metabolic activities [Love 1970].

Brett [1979] investigated body composition in young sockeye, *Oncorhynchus nerka* in relation to temperatures and rations. As with other studies, protein and lipid contents showed inverse linear relation. Groves [1970] reported that protein, water and ash were closely related to each other and to fork-length in young sockeye ranging between 0.5-2500g.

Elliott [1976] found that whole body water (%) decreased linearly and whole body protein and lipid (%) increased linearly with ration size. Water content (%) bore a close inverse relation to lipid. The result of the present study is in accordance with this. Many researchers have developed predictive equations and it was concluded that the body composition of fish could be analyzed with high degree of accuracy from water contents using regression equations.

Condition factor is considered to be one of the factors influencing body composition in fish [Groves 1970, Caulton and Bursell 1977, Salam and Davies 1994]. This is also true for *O. mossambicus* as highly significant ($P < 0.001$) positive correlation exists between condition factor and wet weight; condition factor and total length as well as between condition factor and other body constituents when all are expressed on % wet weight basis except % water content which showed highly significant ($P < 0.001$) inverse correlation with condition factor as shown in Table 1. So it was found that in *O. mossambicus* condition factor increased significantly with increasing wet weight and total length of fish. The negative correlation between condition factor and % water and positive correlation between condition factor and protein (%, wet weight) may be due the fact that fastly growing fishes add new tissues in the form of muscles, which are largely proteins. The positive correlation between condition factor and fat content (%, wet weight) shows that fat increases with increasing size of *O. mossambicus* i.e. this fish becomes healthier as size increases.

It was concluded that body length and weight significantly affect body constituents. If only the water content is determined, the equations provide satisfactory estimates of organic, fat, protein and ash contents. Based on the results, equations were developed to describe the relationship between total length and other body constituents; between wet body weight and other body constituents; and between condition factor and body constituents.

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